Northeastern Area
State & Private Forestry

FOREST PEST MANAGEMENT

US DEPARTMENT OF AGRICULTURE
FOREST SERVICE

S-2-74

EVALUATION REPORT

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ABSTRACT

Dipel (*Bacillus thuringiensis*) applied at the rate of 1 lb. (8 B.I.U. and 1/2 lb. (4 B.I.U.) per acre from air against the redhumped oakworm, *Symmerista canicosta* Franclemont, in Iowa did not give conclusive results. Significantly lower larval survival was found in 1/2 lb. Bt treated blocks than in the checks. Good control in terms of larval mortality (80%) was achieved on three spray blocks, but poor control (16%) on the fourth. No significant differences in larval mortality were apparent between the two application rates.

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AERIAL APPLICATION OF DIPEL (Bt) AGAINST THE REDHUMPED OAKWORM, *Symmerista canicosta* Franclemont, IN IOWA[4/]

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INTRODUCTION

The redhumped oakworm, *Symmerista canicosta* Franclemont, is a late summer defoliator of oak. During the outbreaks, caterpillars become very numerous causing nuisance to residents and visitors in the area. The major damage occurs from larval littering, odor of dying larvae and loss of shade.

Several chemical insecticides are effective against the oakworm larvae (Millers and Wallner, 1974)[5/]. However, a biological insecticide, such as Bt (*Bacillus thuringiensis* Berliner), may be desirable in certain situations. Dipel, a Bt formulation produced by Abbott Laboratories, is one of the more common biological pesticides used in insect control. It was field tested by the authors on small acreages in Michigan in 1972. One-half pound of Dipel (8 billion I.U. of Bt) was applied from air in 2 gallons of water per acre. The material appeared promising, but the larval mortality rates varied considerably by replications. This report presents results of similar tests against the redhumped oakworm in Iowa in 1973.

OBJECTIVES

To determine the effectiveness of 1/2 lb. and 1 lb. Dipel (4 and 8 billion I.U. of Bt) applied from helicopter as 1 gallon water suspension per acre against the early instars of redhumped oakworm.

4/ The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

This publication reports evaluation of pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

5/ Field tests to control redhumped oakworm in Michigan with helicopter application of carbaryl, malathion, resmethrin and Zectran in 1973. USDA Forest Service, NA report in press.

METHODS

The pilot test was located in the northwestern part of Iowa (Figure 1). The topography in the spray area was deep gullies along hillsides, where a moderate stocking of burr oak was present on the slopes. The trees were about 50 ft. tall.

The spray blocks were laid out within a mile radius from the heliport (Figure 1). Each block was about 40 acres. The corners of the blocks were marked with balloons as needed. The blocks were separated adequately to prevent cross contamination. The treatments were 1/2 lb., 1 lb. and checks (no spraying), each replicated twice. Originally, 3 replications were planned, but the oakworm population distribution was such that the number of test blocks had to be reduced.

The oakworm population estimates were made 2-3 days before spraying and again 10-11 days after spraying. Two of the blocks had 40 sample branches each, while the other 4 had 25 branches each. The number of branches was reduced because of the difficulty locating adequate samples. Each sample branch was a twig, or a group of twigs, with about 100 leaves found within arm's reach of the ground. A sample branch was flagged and numbered only when larvae were present. Near the sample branch, another branch without larvae was marked as X-branch (when necessary, larvae were removed from the latter branch) to measure larval migration.

The spray formulations were prepared in the field. The slurry was prepared with 25 lbs. of Dipel powder mixed with 1 gallon Chevron sticker and 10 gallons of water. The slurry contained 2-1/3 lbs. of Dipel per gallon. Further dilution was made later when the helicopter was loaded. For the 1/2 lb. rate, 8 gallons of slurry were mixed with 32 gallons of water to give 40 gallons of finished spray. The 1 lb. rate was prepared by mixing 16 gallons of slurry with 24 gallons of water. It should be noted that this procedure resulted in having 2% Chevron sticker for 1/2 lb. rate and 4% sticker for the 1 lb. rate.

The spray was applied by helicopter on August 10, 1973, between 4 and 6 o'clock in the afternoon. The helicopter was equipped with 6 hollow cone, D-4 nozzles. The system was calibrated to apply 1 gallon per acre when flying at 35 mph about 50 ft. above the tree tops. The sky was clear, wind 0-2 mph, with temperature 85°F at the start and 90°F at the finish. Observations from the ground indicated good settling of the spray. Black spray cards showed good droplet patterns.

RESULTS

The number of branches examined and the average number of larvae found in pre- and post-spray surveys are shown in Table 1. The total number of branches examined in the pre-spray survey include all the branches looked at, both with and without larvae. When 25, or 40 for some blocks, were

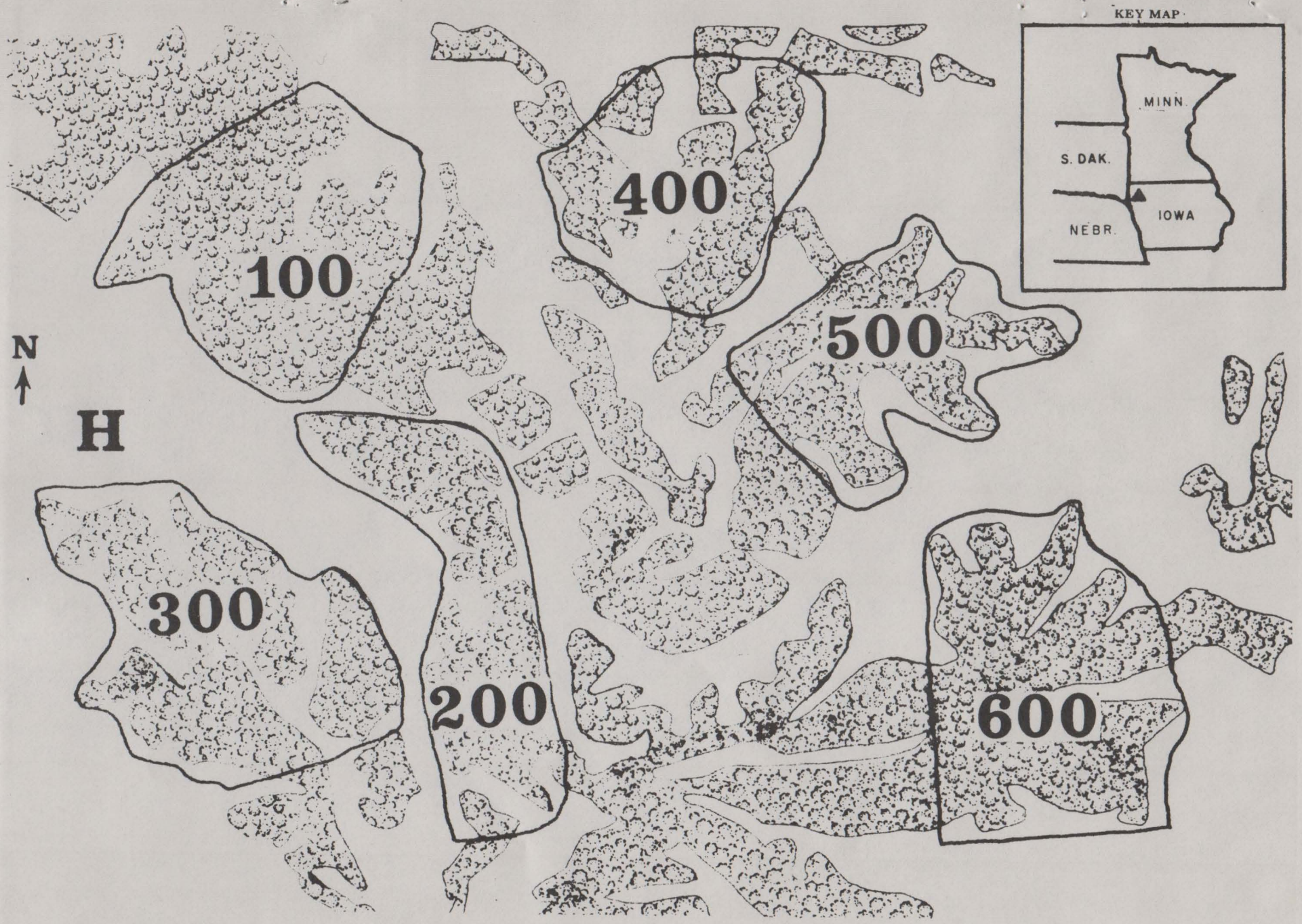

Figure 1. Spray blocks in Iowa Dipel tests. Scale: 4 inches per mile. (H=heliport)

found with larvae, these were marked as sample branches. The average number of larvae per branch in the pre-spray survey (Table 1) is based on sample branches only. For the post-spray survey, the average number of larvae is given for both, sample branches, and an equal number of X-branches. The latter were marked in pre-spray survey, when no larvae were found on the branches. Thus, the post-spray X-branches include the pre-spray branches found without larvae, and a given number of similar branches added to equal the total number of sample branches. Three methods of analysis are used to determine the effectiveness of control.

1. Sample branch method

The first method is a comparison of larval populations before and after spraying on sample branches alone in the various treatment blocks. The survival is calculated as follows:

$$\text{Survival } \% = \frac{\text{No. in post-spray}}{\text{No. in pre-spray}} \times 100$$

No significant differences (t = 10%) were found between any of the treatment blocks (Table 2).

Examination of the data in Table 1 shows that a considerable number of larvae had migrated to the X-branches (from 1.0-29.1 larvae per branch). If one assumes that migration is density dependent and only in the direction from populated branches to non-populated ones, then it is a reasonable conclusion that not all the "loss of larvae" is due to mortality.

2. Total branch method

A second method of analysis is used, where the average number of larvae per branch is based on the total number of branches (infested and X-branches) examined in the field. Thus, pre-spray survey branches include branches without larvae, and post-spray includes all the X-branches. The survival percentages were determined as before. On the basis of this method of analysis, significantly lower survival (t = 10%) occurred on the 1/2 lb. Bt treatment than on the check. No significant difference is found between check and 1 lb. treatment, or check and all Bt treatments combined, or within Bt treatments (Table 2).

3. Calculated branch method

In the total branch method of analysis the assumption is made that larval populations in the postspray sample have assumed pre-spray distribution. However, none of the pre-spray populations had half of the branches without larvae. The calculated branch method is used in an attempt to approach a random sample and use the same proportion of colonized branches before and after spraying. Since non-populated branches, or X-branches were added during the pre-spray survey to match the number of sample branches, then additional sample branches should be taken in the post-spray survey to re-establish the previous ratio (Table 3).

Table 1. Redhumped oakworm populations before and after spraying in Iowa.

Treatment and Block	BRANCHES		PRESPRAY		POSTSPRAY			
			Larvae		on sample branches		on X-branches	
	Total Examined	With Larvae	Ave. No.	SD[1/]	Ave. No.	SD	Ave. No.	SD
	Number of larvae per branch							
Check								
400	43	25	71.8	46.0	24.2	28.9	8.5	22.5
500	49	25	41.4	28.1	13.2	16.6	4.6	12.3
1/2 lb. Bt								
300	55	40	55.8	49.5	2.4	7.5	1.0	10.2
600	25	25	280.6	210.4	46.6	68.7	29.1	36.9
1 lb. Bt								
100	43	25	238.8	301.1	67.3	112.9	25.4	46.8
200	53	40	52.2	36.0	3.2	8.9	1.8	6.1

1/ SD = Standard Deviation

Table 2. Redhumped oakworm survival under different treatments in Iowa Bt tests - 1973

Treatment and Block No.	METHOD OF BRANCH ANALSIS		
	Sample	Total	Calculated
	Percent		
Check			
400	33.7	39.3	42.3
500	31.9	42.2	42.6
Average	32.80 a[1/]	40.75 a	42.45 a
1/2 Pound Bt			
300	4.4	4.2	5.0
600	16.6	13.5	13.5
Average	10.50 a	8.85 b	9.25 b
1 Pound Bt			
100	28.2	33.4	35.8
200	6.1	6.3	7.3
Average	17.15 a	19.85 a,b	21.55 a,b
All Bt			
100	28.2	33.4	35.8
200	6.1	6.3	7.3
300	4.4	4.2	5.0
400	16.6	13.5	13.5
Average	13.82 a	14.35 a,b	15.40 b

1/ Like letters indicate no statistical difference at 10% level of t. Comparisons are valid only for items of same columns, i.e. method of analysis.

For example, Block 400 had a total of 43 branches examined at random in the pre-spray survey, of which 25 had larvae (Table 1). We can assume that the 25 X-branches in the post-spray survey represent the 18/25ths non-populated branches. The total number of branches that we should have examined is 59.7, instead of the 50 that we did (Table 3). The additional 9.7 branches must be sample branches with the average number of larvae per branch in the post-spray survey. Now, if we add the total number of larvae, a new calculated total is obtained (Table 3):

25 sample branches in the field x 24.2 larvae/branch	= 605
25 X-branches x 8.5 larvae/branch	= 213
9.7 additional sample branches x 24.2 larvae/branch	= 235
Total no. larvae	=1053
Ave. no. larvae	= 17.6

The survival of larvae with the calculated branch method shows that significantly lower (t = 10%) survival occurred between 1/2 lb. Bt treatments and the checks, as well as between the checks and all the Bt treatments (Table 2).

The land manager is more interested in the mortality and control achieved with the 2 rates of Bt treatments. Mortality percentages are the reverse of survival percentages in Table 2. About 60% larval mortality occurred from natural causes. This high mortality probably includes larval migration from the sparse foliage on the lower branches to the greener upper crowns. However, parasitism, diseases and starvation are also possible explanations, since the outbreak was in its second year, and larval populations were very high.

The mortality percentages between 1/2 lb. and 1 lb. Bt treatments were similar in 3 blocks (near 90%) but very low in one (Block 100, 60-70%). Nothing in the field notes provides an explanation for the low mortality.

Control here is defined as the effective mortality caused by the Bt treatment alone. The percentage of control is calculated as follows:

$$1 - \frac{\text{\% larval survival in Bt}}{\text{\% larval survival in check}} \times 100 = \text{\% Control}$$

Estimates of control were made for all three methods (Table 4). Good control (above 80%) was achieved in Blocks 200 and 300, 1 lb. and 1/2 lb. Bt treatment, respectively. Block 600 (1/2 lb. Bt) has only 49% control measures with sample branch method, but near 70% with total and calculated branch methods. All 3 methods of evaluation resulted in poor control (14-16%) in Block 100 (1 lb. Bt). Because of the large variation within the two 1 lb. Bt treatments, no significant difference (t = 10%) can be established between the 2 rates of treatment.

Table 3. Calculated number of branches and larvae to establish equal proportion of X-branches to sample branches for pre- and post-spray surveys.

Treatment	Block No.	CALCULATED BRANCHES Total	Added	CALCULATED LARVAE Total	Average
		Number			
Check	400	59.7	9.7	1053	17.6
	500	51.0	1.0	458	9.0
1/2 Pound Bt	300	146.7	66.7	296	2.0
	600	50.0	0	1892	37.8
1 Pound Bt	100	59.7	9.7	2979	49.7
	200	163.1	83.1	467	2.9

Table 4. Oakworm mortality and effectiveness of control due to Bt treatments in Iowa tests. Calculations based on 3 methods.

TREATMENT	BLOCK	SAMPLE BRANCHES MORTALITY	CONTROL	ALL THE BRANCHES MORTALITY	CONTROL	CALCULATED BRANCHES MORTALITY	CONTROL
		no.	%	no.	%	no.	%
Check	400	66.3	----	60.7	----	57.7	----
	500	68.1	----	57.8	----	57.4	----
	Ave.	67.2	----	59.2	----	57.6	----
1/2 lb.	300	95.6	86.6	95.8	89.7	95.0	88.2
	600	83.4	49.4	86.5	66.9	86.5	68.2
	Ave.	89.5	68.0	90.6	78.3	90.8	78.2
1 lb.	100	71.8	14.0	66.6	18.1	64.2	15.7
	200	93.9	81.4	93.7	84.6	92.7	82.8
	Ave.	82.8	47.7	80.2	51.4	78.4	49.2

CONCLUSION

Dipel treatments in Iowa did not give conclusive results. Statistically significant lower survival occurred in 1/2 lb. Bt treated plots than in untreated plots. However, no significant difference could be established between 1 lb. Bt treatment and check, probably because of low number of replicates and high variation in 1 lb. Bt treatment plots. Barely significant differences were observed between survival of larvae in all Bt treated blocks and the checks.

RECOMMENDATION

1. Dipel appears promising for redhumped oakworm control. However, it's use cannot be recommended on the basis of the variability of results in the Iowa test.

2. Future tests with Dipel should determine probable cause for the variability in effectiveness.

ACKNOWLEDGMENTS

Special appreciation is expressed to Mr. Duane Bedford, Forester with the Iowa Forestry Division, for his field arrangements and technical assistance. Without him this project could not have been carried out. Statistical assistance was provided by Mr. Paul Laidly, North Central Forest Experiment Station. Thanks are also due to the many reviewers and consultants who assisted in the preparation of the plans.